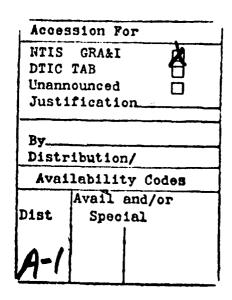# Predicting Short Versus Long Hospital Stay
for Navy Personnel with a Back Problem

Brock Kilbourne, Ph.D.[1]
Charles Chesson, LT, MSC, USNR
Susan Hilton, M.A.

Health Psychology Department
Naval Health Research Center
P.O. Box 85122
San Diego, CA. 92138-9174

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Summary

Problem

The U.S. Navy is particularly concerned with improving cost-effective, quality care to active duty, enlisted Navy personnel with back problems. Optimal use of limited resources demands that hospitalized individuals be humanely and effectively treated, and expeditiously returned to duty. That approach to health care helps to explain administrators' increasing interest in accurately predicting term-of-stay for hospital admissions.

Objective

The purpose of the present study was to examine the relationship between medical and non-medical factors (i.e., severity of back problem, year of hospitalization, and type of admission) and short versus long hospital stay for Navy personnel with a back problem.

Approach

The sample (N=19,134) consisted of all hospitalized cases of active duty, enlisted Navy personnel between 1974 and 1983, inclusive, with a back problem as the primary diagnosis.

Results

Results indicated that a small percentage of back-problem cases accounted for a disproportionate number of total hospital days, and that short versus long hospital stay was related to severity of back problem, year of hospitalization, and type of admission (i.e., direct versus transfer).

Conclusions

Hospital policy impacts considerably upon the length of hospital stay of active duty, enlisted Navy personnel with back problems. Future research should be directed toward understanding the relationship between the hospital normative structure and hospital costs.

Introduction

Rising medical costs in recent years, along with the growing concern about quality patient care, have challenged medical administrators to assure the cost-effective delivery of quality health care (Flood, Scott, & Brown, Jr., 1987). The U.S. Navy is particularly concerned with improving cost-effective, quality care to active duty, enlisted Navy personnel with back problems. Optimal use of limited resources demands that hospitalized individuals be humanely and effectively treated, and expeditiously returned to duty. One way hospital administrators assess costs is to calculate term-of-stay for different kinds of hospital admissions. That approach to cost-assessment is exemplified in the development of fixed payments for inpatient stays for particular diagnosis-related groups (DRGs).

A little-investigated area in regard to health care policy and cost-assessment concerns the interaction between the severity of a back problem and hospital policy. While the severity of a back problem can generally be expected to increase hospital costs, it is less clear how hospital policy, formal and/or informal, interacts with medical severity or new forms of treatment. Different kinds of hospital policy or practices may interact with or function relatively independent of medical severity in predicting length of hospital stay.

The purpose of the present study, then, was to examine the relationship between medical and non-medical factors and length of hospital stay for Navy personnel with a back problem. More specifically, the purpose was to assess the extent to which year of hospitalization and type of admission interact with the severity of a back problem to predict short versus long hospital stay. That focus was intended to illuminate the nature of certain hospital costs, and to suggest policies for reducing such costs.

Methods

Participants

The sample (N=19,134) consisted of all hospitalized cases of active duty, enlisted Navy Personnel between 1974 and 1983, inclusive, with a back problem as the primary diagnosis. The majority of the sample was white (88%), male (93%), and had a high school education or equivalency (73%). The average age was 26.2 (sd=7.3) with a range from 17 to 59 years. The median paygrade was an E-4 with a range from E-1 to E-9. Additionally, the sample was charac-

terized by the following: 1) the average length of hospital stay was 16.4 days (sd=25.9), 2) there were 27% low severity back-problem cases, 50% moderate severity back-problem cases, and 22% high severity back-problem cases, 3) 56% of the back-problem cases were hospitalized between 1974 and 1978 while 44% of the back-problem cases were hospitalized between 1979 and 1983, and 4) 94% of the back-problem cases were direct admissions, 4% were Air Force, Army, or Navy transfers, and 2% were other medical transfers.

Procedures

Data Collection Procedures. Data were obtained from the Navy Enlisted Career/Medical History File (NECMHF). NECMHF is based on two compiled files. One is the Service History File, which consists of demographic and military-service history data from Navy Military Personnel Command in Arlington, Virginia. The other is the Medical History File, which contains hospitalization, death, Medical Board action, and Physical Evaluation Board action data from Naval Medical Data Services Center in Bethesda, Maryland. NECMHF is compiled and maintained by the Naval Health Research Center, San Diego, CA. (Garland et al., 1987).

Coding Procedures. An initial inspection of the data indicated a highly skewed (positive) frequency distribution of number of days in the hospital for back-problem cases. Approximately 85% of all back-problem cases were in the hospital for 30 days or less and accounted for 42% of total hospital days. The remaining 15% of back-problem cases, which were in the hospital 31 days or more, accounted for 58% of total hospital days. Number of days in the hospital was collapsed, therefore, to an ordinal variable (short hospital stay [30 days or less] versus long hospital stay [31 days or more]) in order to create two empirical groups and to facilitate comparison with other ordinal variables. The 31 day cut off point reflected the extreme tail of the skewed distribution. Two orthopedists and one anesthesiologist rank-ordered the medical severity of nine back-problem diagnoses (all Spearman rho coefficients $\geq.77$, all p values $<.01$).[2] The rank orderings were collapsed into the following ordinal levels of severity of back problem: 1) mild severity--open back wound, sprain or strain of the sacroiliac region, and sprain or strain of other or unspecified back part; 2) moderate severity--affection of the sacroiliac joint, vertebrogenic pain syndrome, and fracture or fracture-dislocation of the vertebral column without spinal cord lesion; and 3) high severity--displacement of an invertebral disc, fracture or fracture-dislo-

cation of the vertebral column with spinal cord lesion, and spinal cord lesion without evidence of spinal bone injury. Year of hospitalization was treated as a categorical ordinal variable (first five years [1974 through 1978] versus second five years [1979 through 1983]) and type of admission was treated as a nominal variable (direct admission, Air Force/ Army/Navy transfer, or other medical transfer).

Results

Chi Square analyses (all p values <.0001) indicated that length of hospital stay was significantly related to severity of back problem (Kendall's tau-b[t_b]=.22, p<.0001), year of hospitalization (t_b=-.17, p<.0001), and type of admission (t_b=.09, p<.0001).[3] The partial tau-b procedure indicated that these three variables were statistically independent for all practical purposes (Agresti & Agresti, 1979; Blalock, 1979). The relationship between length of hospital stay and severity of back problem remained essentially unchanged when controlling for year of hospitalization (tau-b-bar[$\bar{t}_b$]=.23) and type of admission ($\bar{t}_b$=.19). The relationship between length of hospital stay and year of hospitalization remained unchanged when controlling for severity of back problem ($\bar{t}_b$=-.17) and type of admission ($\bar{t}_b$=-.17). The relationship between length of hospital stay and type of admission remained essentially unchanged when controlling for severity of back problem ($\bar{t}_b$=.08) and year of hospitalization ($\bar{t}_b$=.12). Table 1 shows the relationships between each of the predictor variables and length of hospital stay when controlling for the other two predictor variables.

These analyses indicated that: 1) individuals with less-severe back problems were likely to spend less time in the hospital than those with more-severe back problems, 2) individuals with a back problem who were admitted during the second five-year period spent less time in the hospital than those admitted during the first five-year period, and 3) individuals with a back problem who were direct admissions spent less time in the hospital than those who transferred from other facilities. The cumulative proportion of reduction in error in classifying a given back problem case involving either a short versus a long hospital stay was 48% for a sample of over 19,000 back-problem cases.[4]

Table 1

**Effect of Control Variables on Relationships of
Medical Discharge Disposition with Predictor Variables**[a]

	Length of Hospital Stay	Control Variables		
		Severity of Diagnosis	Year of Hospitalization	Type of Admission
Severity of Diagnosis	.22	--	.23	.19
Year of Hospitalization	-.17	-.17	--	-.17
Type of Admission	.09	.08	.12	--

[a]All table values represent tau-b coefficients of Length of Hospital Stay with the row (predictor) variables.

A loglinear analysis (logit) was then conducted to compute parameter estimates and to assess, using two-tailed z tests, interaction and contrast effects within levels of the variables. Logit is a modified regression procedure for categorical data (Goodman, 1972; Knoke & Burke, 1980). The logit model indicated a good fit with the data (Likelihood Chi-square=.99, df=4, p=.91).[5] The concentration measure of association, which is analogous to Goodman and Kruskal's tau-b and which indicates the strength of the association between the dependent variable (i.e., length of hospital stay) and the predictor variables, was 11%. Haberman (1982) cautions, however, that the concentration measure may underestimate the magnitude of association in the model.

Simple contrast comparisons in the logit model indicated the following main effects: 1) individuals with low- or moderate-severity back problems were likely to spend less time in the hospital than those with high-severity back problems (both p values <.001), 2) individuals with back problems who were admitted into the hospital during the first five-year period were likely to spend more time in the hospital than those admitted during the second five-year period (p<.001), and 3) individuals with back problems who transferred

into the hospital from another facility were likely to spend more time in the hospital than those who were direct admissions (both p values <.001). These findings were consistent with the Chi-square and tau-b analyses.

However, the contrast comparisons in the logit model also indicated inter-action effects. First, compared to individuals with high-severity back problems during the second five-year period, individuals with low-severity back problems during the first five-year period spent less time in the hospital than statistically expected (p<.05). This interaction attenuated the main effects of severity of back problem and year of hospitalization. Second, compared to individuals with high-severity back problems who were direct admissions, individuals with low- or moderate- severity back problems who transferred spent less time in the hospital than statistically expected (both p values < .05). These two interactions attenuated the main effects of severity of back problem and type of admission. Third, compared to individuals with back problems who were direct admissions during the second five-year period, individuals with back problems who transferred into the hospital during the first five-year period spent longer in the hospital than statistically expected (p<.01). This interaction accentuated the main effects of year of hospitalization and type of admission.

Additionally, in order to identify year by year change in relation to the full range of days spent in the hospital, days in the hospital and year of hospitalization were treated as interval level variables, and severity of back problem and type of admission were treated as dummy variables (Blalock, 1979). Table 2 shows the average number of days in the hospital as a function of year of hospitalization, and the decreasing trend in length of hospital stay across the ten-year time period of the study. A forced-entry multiple regression analysis, using orthogonal polynomial (linear) coefficients, was computed to determine the contribution of the non-medical predictors after initial entry of the medical predictor.[6] Severity of back problem explained approximately 7% of the variance. Year of hospitalization and type of admission explained an additional 11% of the variance (see Table 3). When all three predictors were included in the regression analysis, they were significantly associated with length of hospitalization (p<.0001) and produced a multiple R of .42. However, year of hospitalization and severity of back problem were the two primary predictors, and explained 16.6% of the variance.

Table 2

Mean Days of Hospitalization as a Function of Year of Hospitalization

Year of Hospitalization	Days in the Hospital		
	Mean	Std Dev	Cases
1974	35.5287	45.4619	2262
1975	24.3167	31.7035	2002
1976	16.7040	21.6396	2132
1977	13.9338	19.4731	2341
1978	12.1078	17.0627	2059
1979	11.1825	16.4019	1753
1980	12.2438	18.8343	1620
1981	10.8346	15.1320	1626
1982	9.8453	13.9988	1590
1983	11.0537	19.3546	1749
Total	16.4237	25.8675	19134

Table 3

Forced-Entry Multiple Regression Analysis Predicting Length of Hospital Stay

Variable	Multiple R	R^2	Beta	t value	p value
High severity	.26	.07	.31	37.8	<.001
Moderate severity	--	--	.11	13.7	<.001
Year of Hospitalization	.41	.17	-.31	-44.7	<.001
Other medical transfer	.42	.18	.07	9.3	<.001
AF/Army/Navy transfer	--	--	.07	9.8	<.001

Discussion

The present study indicated that most (85%) active duty, enlisted Navy personnel with a back problem as the primary diagnosis spent 30 days or less in the hospital. A short stay in the hospital was associated with less-severe back problems, direct admissions, and hospitalization during the second five-year period of the study. On the other hand, a small percentage (15%) of active duty, enlisted Navy personnel with a back problem were more likely to

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spend 31 days or longer in the hospital and accounted for a disproportionate number of total days in the hospital (58%). These longer hospitalizations were associated with more-severe back problems, medical transfers from other facilities, and hospitalization during the first five-year period of the present study. Both the partial tau-b analyses and the logit analyses indicated that severity of back problem, year of hospitalization, and type of admission each made relatively independent contributions in predicting short versus long hospital stay for active duty, enlisted Navy personnel with a back problem. In the tau-b analyses, these three predictors reduced the error in classifying short versus long hospital stay by nearly 50% for a sample of over 19,000 Navy personnel.

In the logit analysis, however, year of hospitalization and type of admission, two non-medical factors, separately attenuated in some instances the effect of the severity of a back problem upon length of hospital stay. Year of hospitalization and type of admission also interacted in some instances to accentuate their respective main effects upon length of hospital stay. Taken together, then, the logit contrast comparisons indicating interaction effects further confirmed that hospital policy has a considerable impact upon short versus long hospital stay of active duty, enlisted Navy personnel with a back problem.

When the interval level or dummy versions of the three predictors were entered into a multiple regression analysis, they together explained approximately 18% of the variance of the length of all hospital stays, not just short versus long hospital stay. That latter finding supports the generality of and increases our confidence in the initial analyses. It also suggests that hospital policy concerning back problem cases has a differential effect on different parameters of hospital stay. For example, type of admission was a good predictor of short versus long hospital stay but a poor predictor of the decreasing trend in length of hospital stay across the ten-year time period of the study. Severity of back problem and year of hospitalization, on the other hand, were good predictors regardless of how length of hospital stay was assessed.

While the present study cannot provide a categorical explanation of the strong effect of year of hospitalization, a number of possible explanations were suggested. First, some formal or informal hospital policy may have been implemented to shorten the length of hospital stay of individuals with a back

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problem. That interpretation is consistent with general trends in Navy hospital practices to reduce hospital costs by shortening length of hospital stay. Although hospital stays were generally longer during the first five-year period than the second five-year period of the study (see Table 2), the most dramatic drop in mean length of hospital stay occurred in 1975 and was followed by steady declines thereafter. Second, since the data set did not include sufficient information on transfers to a medical holding company, it is not possible to conclude categorically that actual reductions in hospital stay occurred. Transfers to a medical holding company within the hospital could have obfuscated the actual length of hospital stay, and may reflect cases which required follow-up or were awaiting administrative action (Kolb, Gunderson, & Coben, 1982). Current policy (NAVMEDCOMINST 1306.72D) concerning medical holding company transfers of personnel from inpatient status to medical hold outpatient status entail a diary change and not a formal transfer. Nonetheless, it should be pointed out that personnel in a medical holding company can be gainfully utilized for Temporary Duty, such that hospital costs associated with continued medical supervision are reduced and a partial return to duty is achieved. Third, improved medical treatment may have impacted upon length of hospitalization, although it is unlikely that new treatments for diverse back-problems as well as their effects would have been simultaneously and dramatically reflected in the same year of hospitalization.

The effect of type of admission on length of hospital stay may similarly reflect the impact of some hospital policy (most likely an informal policy) on discharge from the hospital. While it is not directly evident in the present data, transfer patients may have consistently received a delayed discharge, perhaps to insure that they would continue to be seen by their hospital physician during the convalescence period, and/or to avoid the extra expense of returning the transfer patient should post-discharge medical complications arise.

In sum, hospital policy concerning back-problem cases impacts on hospital costs relatively independent of medical severity. Normative policies and procedures within the hospital setting (formal and/or informal) intended to reduce the number of admissions and/or to reduce the length of hospital stay have the effect of reducing hospital costs. The present study suggests that Navy hospital administrators have attempted to reduce hospital costs by limiting the length of hospital stay for active duty, enlisted Navy personnel

with a back problem as the primary diagnosis. However, the absence of information on medical holding company transfers as well as on improved treatment procedures precludes a comprehensive understanding of the exact cause(s) of shorter hospital stays or how to calculate specific cost benefits. Lastly, the effect of type of admission on length of hospital stay suggests that the practice of delaying the discharge of patients transferred to the hospital from other facilities is significantly related to longer hospital stays (therefore greater costs) and deserves further investigation.

Footnotes

[1] Brock Kilbourne is a Research Associate with the National Research Council, National Academy of Sciences.

[2] The nine back-problem diagnoses were general categories or headings for a combination of specific, related codes from the ICDA-8, ICD-9, and DDDIC. The strategy of combining similar codes under a general heading facilitated comparison of different diagnostic categories, although it also probably reduced the degree of agreement between raters and the strength of the relationship between severity of back problem and length of hospital stay.

[3] Kendall's tau-b has a proportional reduction in error interpretation and can be used to compute a summary partial tau-b measure (tau-b-bar) to control for third variables of any scale (Agresti, 1977; Agresti & Agresti, 1979).

[4] Similarly, when a new variable was created to assess the effect of multiple admissions (one admission versus more than one admission), it was found that having a history of more than one admission did not relate to short versus long hospital stay (p=.65). Also, the reported tau-b relationships between each of the three predictors and length of hospital stay were essentially unaffected when controlling for age, educational level, multiple admissions, paygrade, race, and sex.

[5] The logit model included the following variable entries: length of hospital stay, length of hospital stay by severity, length of hospital stay by year of hospitalization, length of hospital stay by type of admission, length of hospital stay by severity by year of hospitalization, length of hospital stay by severity by type of admission, length of hospital stay by year of hospitalization by type of admission.

[6] Four groups were formed that corresponded to the following years: 1974; 1975; 1976; and 1977-1983.

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The purpose of the present study was to examine the relationship between medical and non-medical factors (i.e., severity of back problem, year of hospitalization, and type of admission) and short versus long hospital stay for Navy personnel with a back problem. The sample (N=19,134) consisted of all hospitalized cases of active duty enlisted Navy personnel between 1974 and 1983, inclusive, with a back problem as the primary diagnosis. Results indicated that a small percentage of back-problem cases accounted for a disproportionate number of total hospital days, and that short versus long hospital stay related to severity of back problem, year of hospitalization, and type of admission (i.e., direct versus transfer). Hospital policy impacts considerably upon the length of hospital stay of active duty enlisted Navy personnel with back problems. Future research should be directed toward understanding the relationship between the hospital normative structure and hospital costs.

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